



# **SMART LANDING FACILITY OPERATIONAL CONCEPT\***

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**\* An Operational Concept for the Smart Landing Facility, MIT Lincoln Laboratory, Project Report NASA/A-4, March 2001**



# Outline

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- **Review of NASA Smart Landing Facility concept**
- **Approach to Operational Concept\* development**
- **CNS/ATM technology assessment**
- **Summary**

# ***“Smart” Landing Facility (from NASA Level 2 briefing)***

**“Smart Landing Facilities” provide automation-enabled separation and sequencing in non-towered, non-radar, terminal airspace and simultaneous non-interfering operations for runway-independent aircraft. Landing facility information and status will be provided to airborne nodes (vehicles) by flight information service including weather, traffic, flight plans, etc. while the commercial service will provide maintenance, fueling, intermodal connection, and other information.**

## **Capabilities**

### **Program Provided**

- **Aircraft separation and sequencing**
- **Runway, taxi directives**
- **Remote tower sensor system, flight and air traffic services and local weather**
- **Seamless interface with NAS**

### ***Other***

- ***Maintenance, Repairs & Services***
- ***Personalized Dispatch Services***
- ***Intermodal Connectivity***
- ***Food & Lodging Info.***
- ***Recreation Info.***





# Smart Landing Facility

## Operational Concept Approach

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- **Define SLF objectives and capabilities**
- **Describe candidate SLF operational environment**
- **Review services provided by ATCT and TRACON**
- **Define high level operational functions of SLF**
- **Survey applicable CNS/ATM technologies**
- **Develop SLF operational scenarios**
- **Identify key enabling CNS/ATM technologies**

***This presentation will focus on CNS technologies for SLF***



# Smart Landing Facility

## *Objectives*

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- **Smart Landing Facility must support**
  - **High volume operations at airports without control towers or terminal radar facilities**
  - **Lower adverse weather landing minimums at minimally equipped landing facilities**
  - **Integration of SATS aircraft into a higher en route capacity air traffic control system with complex flows and slower aircraft**
  - **Improved single-pilot ability to function competently in complex airspace in an evolving NAS**



# **Smart Landing Facility**

## ***Operational Capabilities***

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- **Surveillance-based separation and sequencing in non-towered non-radar terminal airspace**
- **Coordination with adjacent ATC facilities**
  - Clearances, releases, and transfer of control, including communication of this information to flight crews
- **Delivery of Flight Information Services (FIS)**
  - Current airport operational information
  - Local weather



# **Smart Landing Facility**

## ***Operational Environment***

- **Mixed operations**
  - **Simultaneous VFR and IFR operations in SLF traffic area**
  - **Minimum equipage: VHF voice radio and Mode C transponder**
  - **Rationale: Existing fleet must continue to have access, but minimum equipage must support electronic surveillance and voice communication**
- **Enhanced capabilities for equipped aircraft**
  - **Data link ATC communication and Flight Information Services supported by SLF**
  - **Precision flight management via manual, supervisory control, or fully-automatic operations**



# Current ATCT Services

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- **Airport configuration determination and dissemination**
- **Separation in airport traffic area, runways, taxiways**
- **Weather observations and dissemination**
- **Delivery of ATC clearances**
- **Coordination with adjacent ATC facilities**
- **Assistance with emergencies**



# Current TRACON Services

- **Surveillance-based separation and sequencing in terminal area**
- **Weather and traffic advisories (workload permitting)**
- **Coordination with adjacent ATC facilities**
- **Assistance with emergencies**

***The principal contributor to increased IFR airport capacity is sequencing and separation provided by the TRACON, not the ATCT***



# Technology Assessment

## *Flight Information Services*

- **Weather observation**
  - Provided today by AWOS/ASOS at non-towered facilities
  - Regional and national weather available to SLF ground system via Internet
  - Improved weather sensors may be required  
e.g., more accurate ceiling and visibility
- **SLF configuration**
  - Requires automated system to determine appropriate runways and instrument approaches
- **FIS communication**
  - VHF voice broadcast of synthesized voice in use today
  - Several mature options are available for data link broadcast



# **Technology Assessment**

## ***Coordination With Adjacent ATC Facilities***

- **Live VHF voice communications in use today**
  - **Remote Communications Outlet (RCO) for adjacent TRACON**
  - **Remote Transmitter-Receiver (RTR) for adjacent ARTCC**
- **Data link communication**
  - **Pre-Departure Clearance (PDC) in use by airlines and could be adapted to use by SLF**
  - **With clearance on file, surveillance system could detect aircraft when it becomes active, thereby automatically requesting IFR release**
  - **Two-way data link communication will be required**



# Technology Assessment

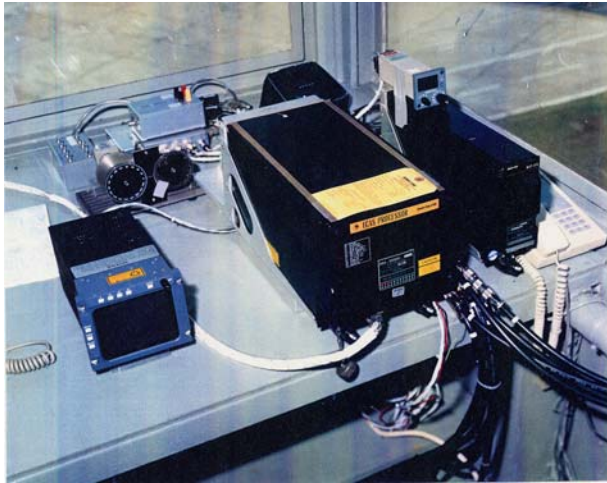
## *Surveillance-Based Sequencing and Separation*

- **Surveillance provided by Small Terminal Sensor (STS)**
  - **Options**
    - Short-range secondary (beacon) radar with rotating antenna or simple phased array
    - Transponder multilateration
    - STS must also be compatible with ADS-B
- **Separation and sequencing provided by automated or semi-automated system**
  - Requires new technology development for this application
  - Key issue: failure detection and recovery

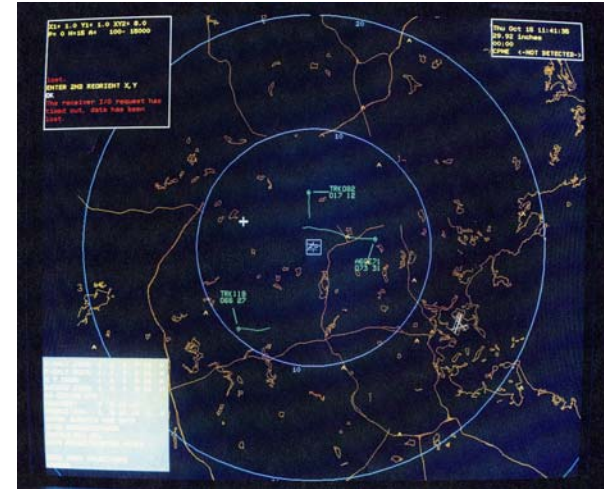


## Small Terminal Sensor

## Example System



## RF Hardware



## Prototype Display

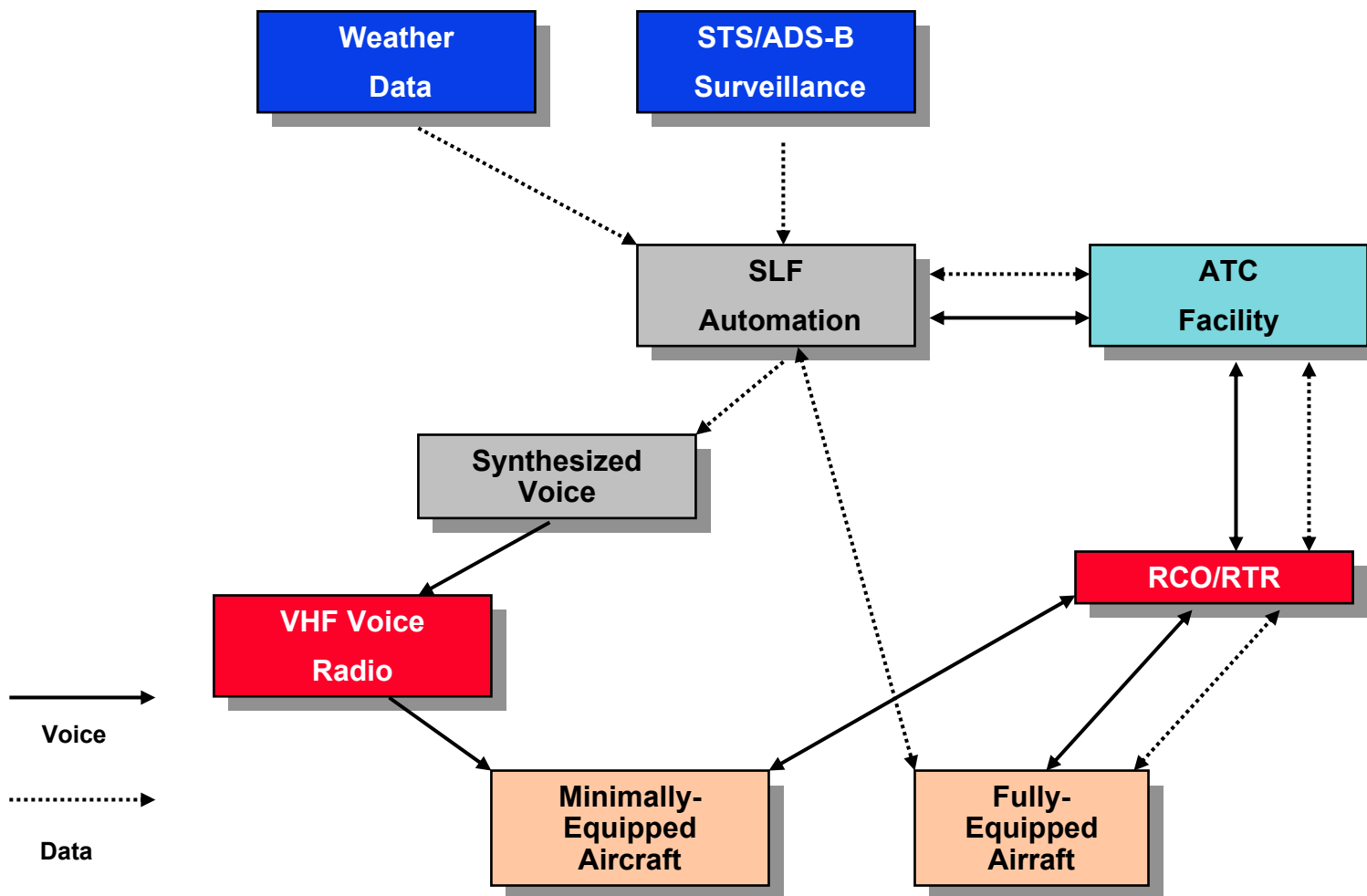


## Tower Installation

- **Modified TCAS hardware**
- **Compact, non-rotating antenna**
- **Range: ~ 20 nmi**
- **Compatible with existing transponders and ADS-B**



# Smart Landing Facility Block Diagram





# Smart Landing Facility

## *Key Research Issues*

- **System Engineering: Small Terminal Sensor**
  - Determine required performance and assess technology options
- **Automated sequencing and separation**
  - Assess feasibility of alternative approaches
    - Fully automated
    - Supervisory control
    - Fully manual

***Surveillance-based sequencing and separation services are necessary to achieve SLF goals***



# Smart Landing Facility

## *Key Research Issues (cont'd)*

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- **ATC data link communication**
  - **System engineering is required to determine an appropriate data link system to accommodate both FIS and two-way ATC communication**
- **Failure detection and recovery**
  - **System engineering is required to determine the appropriate techniques for the automated functions of SLF to detect and recover from failures of ground and aircraft systems**



# Summary

- **An operational concept has been developed for the Smart Landing Facility**
- **Enabling technologies have been identified and an assessment made of their importance and maturity**
- **Key research issues have been identified**
- **System engineering should be an early SATS activity**
  - **Surveillance and communication system for SLF**
  - **The role of automated sequencing and separation**
  - **Failure detection and recovery**